

# Current Characteristics of Rural Motor-Vehicle Speeds (Indiana)

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THE project has observed vehicle speeds in various parts of Indiana since 1939. In recent years, periodic observations have been made at six rural locations. Two of these locations are on four-lane, divided highways and four are on two-lane highways. The average speeds of Indiana passenger cars are compared with those of non-Indiana cars and the effect of highway type on speeds is discussed. The apparent effect of the change from a "reasonable and proper" state-wide speed limit to a 65-mph., *prima facie*, state-wide limit for passenger cars and trucks up to 5,000 lb. is also presented. The paper is concluded by a discussion of the trends in speed differential as typified by the eighty-fifth passenger car percentile speed and the fifteenth heavy truck percentile speed.

● IN a dynamic society it is natural that increasing emphasis be placed upon speed and mobility. This emphasis has resulted in the production of new cars which are capable of achieving very high speeds in short periods of time. New highways with design speeds of 70 mph. are also the result of public demand. Meanwhile, other segments of the public are calling for reduced speeds through the use of restrictive devices such as lower speed limits or the placement of automatic speed governors on motor vehicles.

Advancements in automotive and highway design have made greater safety possible at high speeds, but many drivers have not been trained or conditioned for the complexities of high speed travel. Smooth highways and comfortable vehicles have resulted in operating speeds which may be twice as fast as the driver thinks he is traveling. Conversely, the superconservative driver, the "Sunday" driver, or the operator of a defective vehicle can be found traveling at speeds which would be commendable in congested residential areas, but are extremely hazardous on the open highway. This uncertainty of human behavior makes it imperative that continued motor vehicle speed observations be made to enable the various engineering, enforcement, legislative, educational, and judicial agencies to better protect the driver.

## INDIANA INTEREST IN THE SPEED PROBLEM

The Joint Highway Research Project of Purdue University initiated the development of speed measuring equipment and the measurement of motor vehicle operating speeds over fifteen years ago. At that time, a speed and acceleration measuring device was developed by A. K. Branham who subsequently described the apparatus to the Highway Research Board in 1941 (1). Most of the early studies were confined to observing driver-reactions to stop signs, warning signs, and similar traffic control devices. Later studies pertained to driver-reaction to physical hazards such as narrow bridges, vertical and horizontal curves, narrow pavements, and narrow shoulders (2, 3, 4).

In more recent years the design of equipment has been limited to apparatus for measuring spot speeds. The latest device, an electronic speed meter, was developed in 1953 in cooperation with the Purdue Campus Electronics Service. This meter utilizes a fully charged capacitor which is discharged while the observed vehicle travels 88 feet between two pneumatic rubber tubes placed across the pavement. The meter "holds" the reading until released and can be used for vehicles approaching from the right or left. The meter has an accuracy of plus or minus one mile per hour.

Speed studies on the rural highways of Indiana were initiated in 1941. Several papers have reported these studies of the Joint Highway Research Project. Included among these are one by R. E. Frost which was presented before the Highway Research Board in 1943 (5) and others which were presented before the Purdue Road School at various times (6, 7, 8, 9, 10).

#### SPEED REGULATIONS IN RURAL INDIANA

Before World War II the basic rule of "reasonable and prudent" speeds was in effect. On March 18, 1942 the Governor of Indiana established a 45 mph. limit to conserve rubber. On July 26, 1942, the limit was lowered to 40 mph. and on September 30, 1942 the entire nation was placed under a 35 mph. limit.

After the elimination of the wartime speed limit of 35 mph. in the fall of 1945, Indiana statewide speed restrictions reverted to the pre-war values of "reasonable and prudent" speeds for all vehicles with a gross weight of less than 5000 pounds: 45 mph. for all trucks with a gross weight of more than 5000 pounds: and 50 mph. for all busses (11).

In March, 1953 the Indiana State Legislature passed legislation which imposed a 65 mph. prima facie limit on all passenger cars. The maximum bus speed was raised from 50 to 55 mph. and the maximum speed of heavy trucks (gross weight in excess of 5000 pounds) remained unchanged at 45 mph. (12).

To the average motorist, the 65 mph. prima facie limit is an absolute limit, because little publicity or explanation has been given to the motorist's liberty to attempt to exonerate him-

self when cited for exceeding the prima facie limit. Few, if any, drivers have attempted to "prove" no violation when arrested for exceeding this limit.

The Indiana Driver Point System, adopted on June 1, 1954, may also act as an additional deterrent to speed limit violations. "A driver amassing 12 or more points within a three-year period, dating back from the latest violation, will be, upon his request, granted a hearing to show why his license should not be suspended". Conviction of exceeding speed limits have a value of three points. Suspension of the operator's license is generally in the range of six months to two years (13).

Present Indiana law (14) contains the following provisions relative to minimum speeds:

No person shall drive a motor vehicle at such a slow speed as to impede or block the normal and reasonable movement of traffic except when reduced speed is necessary for safe operation or in compliance with the law.

Police officers are hereby authorized to enforce this provision by directions to drivers, and in the event of apparent willful disobedience to this provision and refusal to comply with direction of an officer in accordance herewith the continued slow operation by a driver shall be a misdemeanor.

#### FIELD PROCEDURES

From 1941 through 1951, rural speed observations were made at many locations throughout the state. Since the spring of 1952, vehicle speeds have been periodically observed at six locations on level tangents which offer excellent passing sight distances, thereby inducing free-moving traffic. Two stations are on a four-lane divided highway and four stations are on two-lane pavements. See Table 1.

All observations were made in daylight and, with few exceptions, under good driving conditions of clear visibility and dry pavement surface. A minimum sample of 500 vehicles was observed at each location and the speeds were recorded to the nearest mile per hour.

Passenger car speeds were identified by state of registration and direction of travel while trucks were identified by weight class and direction of travel. Gross truck weights were estimated and classified by the observer as being less than 5000 pounds (light trucks) or more than 5000 pounds (heavy trucks).

Bus speeds were also recorded but a report of trends is not practicable because of the small number of observations.

TABLE 1  
PRESENT INDIANA RURAL SPEED  
OBSERVATION STATIONS

Rt.	Location	No. of Lanes	Pave-ment Width (ft.)	Est. 1954 ADT Vol. (vpd.)
US 52	1.0 mi. So. of So. Jet, SR 28	4 (divided)	2 @ 24	6600
US 52	1.0 mi. West of Klondike	4 (divided)	2 @ 24	7600
US 52	1.2 mi. West of Templeton	2	22.5	4700
US 41	1.5 mi. No. of Boswell	2	22.5	2500
US 31	7.2 mi. No. of Perrysburg	2	22.5	2700
SR 25	1.0 mi. So. of Americus	2	22	2920

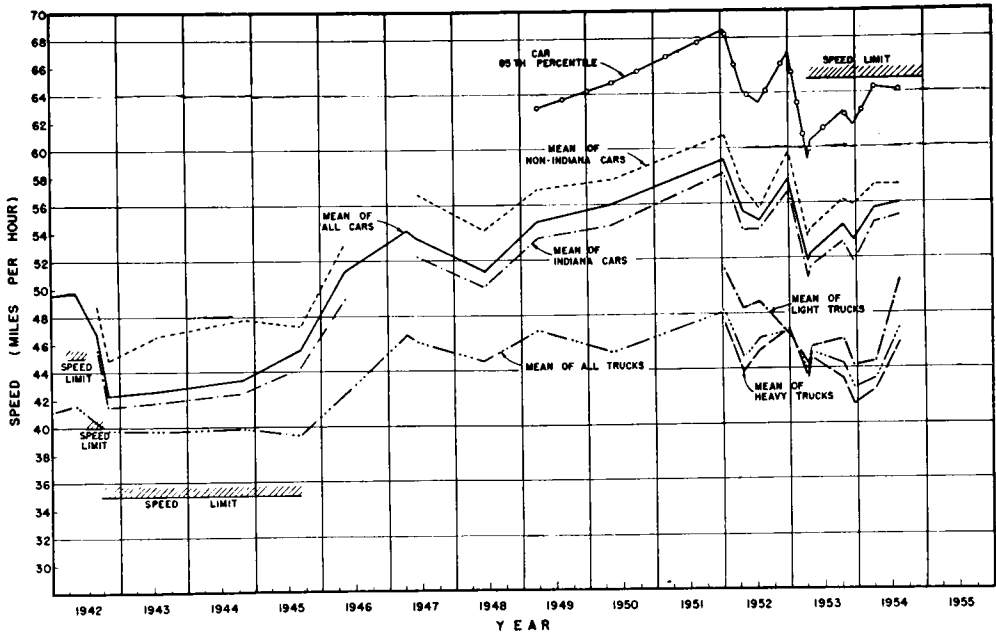


Figure 1. Indiana rural speed trends, 1942-1954.

#### PASSENGER-CAR SPEEDS

An investigation of the various Joint Highway Research Project speed studies indicates that the sharp reduction of Indiana rural motor vehicle speeds during the early part of World War II, was more than recovered in the two year period following the end of the war and the subsequent elimination of the wartime 35 mph. speed limit. As shown in Figure 1, the mean speed for all passenger cars increased from 42.3 mph. at the end of October, 1942, to 59.2 mph. in early January, 1952. For no apparent reason the mean speed for passenger cars decreased to 55.4 mph. and 54.7 mph. during the spring and fall of 1952, and increased to 57.7 mph. at the end of December, 1952.

In March, 1953 a *prima facie* speed limit of 65 mph. superseded the basic limit of "reasonable and prudent" speeds. One month later, the mean speeds for Indiana and non-Indiana cars were 6.2 mph. below the values for December, 1952. This is a significant decrease as determined by a statistical analysis of the observed means before and after the imposition of the speed limit. This analysis revealed that any difference in means (by use of the *t* test), greater than 1.0 mph. for Indiana cars and 1.5 mph. for non-Indiana cars, was significant

at the one percent level. While at least part of this sudden decrease might be attributed to the enactment and extensive publicity of the new speed limit, passenger car speeds have increased since that time.

This aspect of driver behavior is also indicated by the 85-percentile speeds of passenger cars observed in the last two years. The increase of 85-percentile speeds indicates that the number of high speeds observed in the sample is increasing. This increase in the high speeds thus disputes the theory that the speed limit tends to increase slower speeds while limiting or even causing a decrease in high speeds.

The tendency of non-Indiana drivers to travel at mean speeds greater than those of Indiana drivers is also evident in Figure 1. Since 1949, the mean speed of non-Indiana cars has been approximately three miles per hour faster than that for Indiana cars.

#### TRUCK SPEEDS

Truck speeds increased steadily from September, 1945 to April, 1947. Since the latter date, however, the mean speed for all trucks has varied from a high value of 48.2 mph. in

January, 1952 to a low value of 42.6 mph. in December, 1953. See Figure 1.

As expected, the mean speed of light trucks was from 0.8 mph. to 4.6 mph. higher than that of heavy trucks except in the observations made in December, 1952 and January, 1953. At that time the mean speed of the heavy trucks was 46.9 mph. while the mean speed of light trucks was 46.6 mph., a negligible difference of 0.3 mph.

#### SPEED CHARACTERISTICS OF PASSENGER CARS

The mean speeds of passenger cars on two-lane highways may be compared with the mean speeds of passenger cars on four-lane divided highways. The upper part of Figure 2 shows the mean speed of Indiana and non-Indiana passenger cars on four-lane divided highways and the lower part shows the mean speeds of passenger cars on two-lane highways. The speed of the non-Indiana cars was always higher than the Indiana car speed on both highway types.

It may be observed for 1950-1951, through a comparison of these curves, that the speeds on four-lane highways increased more rapidly than the speeds on two-lane highways. The greatest decrease following the enactment of the 65 mph. speed limit was also observed on the 4-lane pavements.

Except for observations in 1947 and 1949, when the mean speed on two-lane highways was 0.5 mph. higher than the mean speed on four-lane highways, Indiana passenger car operators took advantage of the favorable design features of four-lane divided highways and travelled faster on these routes (see Figure 3). Non-Indiana operators acted similarly except in 1949 when the mean speed on two-lane highways was 0.4 mph. faster than the mean speed on four-lane highways.

The difference between the mean speeds of non-Indiana passenger cars and Indiana cars on two-lane and four-lane highways has fluctuated between one and six miles per hour since 1946 (see upper part of Figure 4). It is interesting to note that in nine of the fifteen observations plotted, the difference between non-Indiana and Indiana mean car speeds was larger on the two-lane pavements.

In the past three years there has been a tendency on the part of both Indiana and non-Indiana passenger car drivers to drive almost as fast on two-lane highways as on four-

lane divided highways. This tendency is indicated by the decreasing value of differences shown in the lower curves of Figure 4. The close proximity and similarity of the Indiana and non-Indiana curves should also be noted.

#### SPEED CHARACTERISTICS OF TRUCKS

Figure 5 shows that there has been a wider range of the values of truck mean speeds observed on the four-lane divided highways than on the two-lane highways. Since 1952, when truck types were first differentiated, light trucks have travelled faster than heavy trucks on the four-lane routes, while the relationship between the speeds of light and heavy trucks on two-lane routes has been variable.

Postwar high values of 56.2 and 50.0 mph. for light and heavy trucks, respectively, were observed on the four-lane divided routes in January, 1952. The speeds then decreased to low values of 43.7 mph. for light trucks (April, 1954) and 40.1 mph. for heavy trucks (December, 1952). Significant increases of 8.4 mph. for light trucks and 3.9 mph. for heavy trucks are shown between April and August, 1954.

Somewhat smaller increases of 4.1 mph. for light trucks and 3.1 mph. for heavy trucks are indicated on two-lane highways for the same period. The August, 1954, light truck mean speed value of 49.9 mph. is the highest ever reported for two-lane pavements.

It should be noted, in both the upper and lower sets of curves in Figure 5, that the mean speed of the heavy trucks (gross weight over 5000 pounds) has often been higher than the 45 mph. absolute statewide speed limit for these vehicles.

As shown in Figure 6, both light and heavy truck operators failed to utilize the inherent opportunities for higher speeds on four-lane divided highways as compared with two-lane highways. This is indicated by the fact that in many instances both light and heavy trucks, especially the latter, had higher mean speeds on the two-lane highways. A higher speed limit for trucks may cause higher speeds on the four-lane routes but as has been noted passenger cars also evidenced a tendency to travel almost as fast on a two-lane highway as on a four-lane highway.

The difference between the speeds of light and heavy trucks was greater on the four-lane pavements than on the two-lane pavements

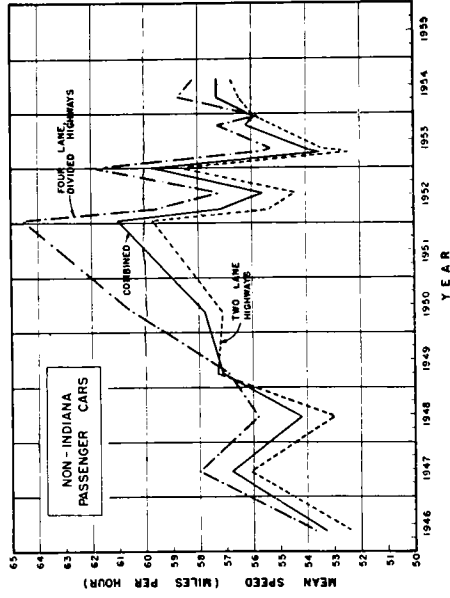
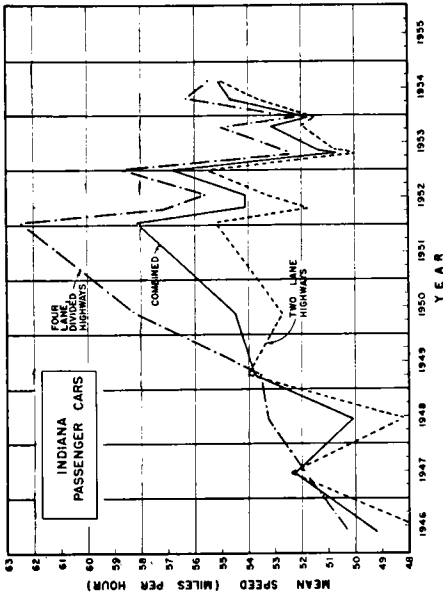


Figure 3. Passenger car mean speeds versus state of vehicle registration.

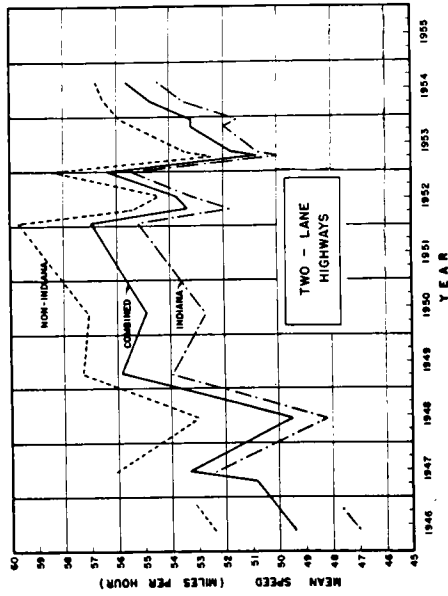
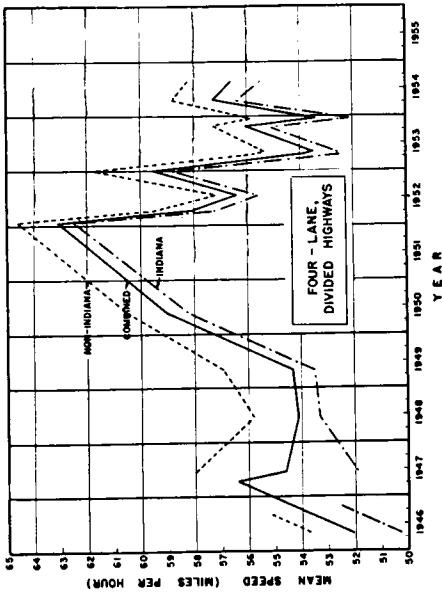


Figure 2. Passenger car mean speeds versus highway type.

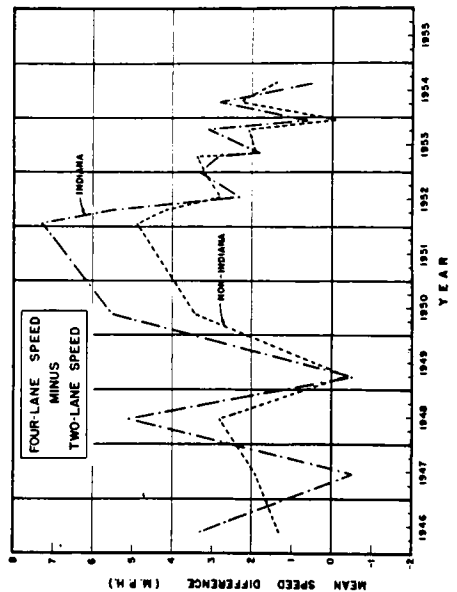
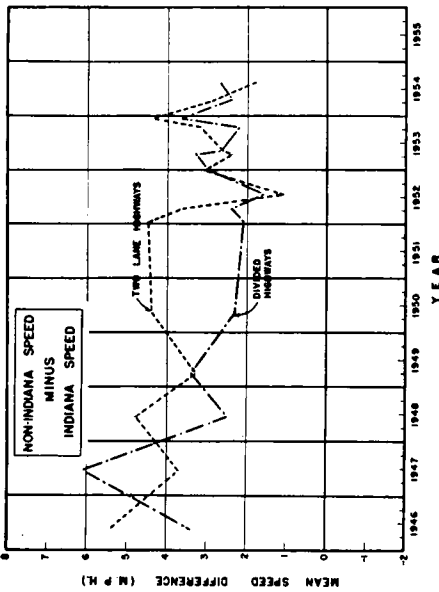
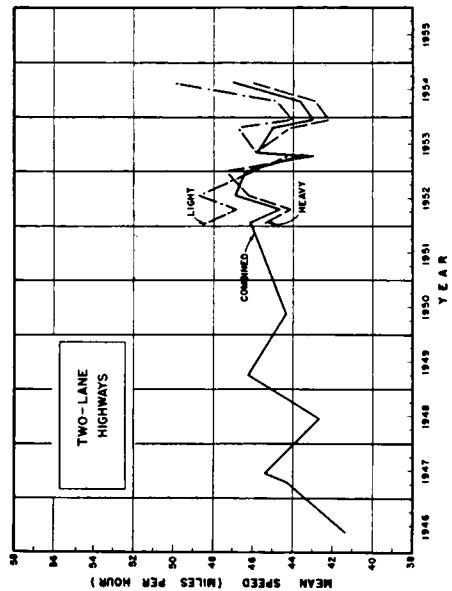
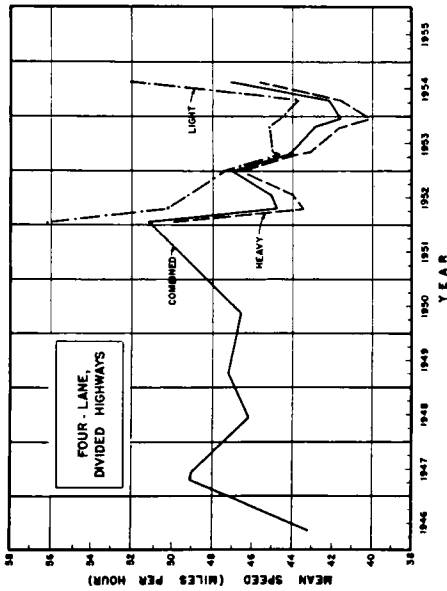


Figure 5. Truck mean speeds versus highway type.

Figure 4. Difference in passenger car mean speeds.

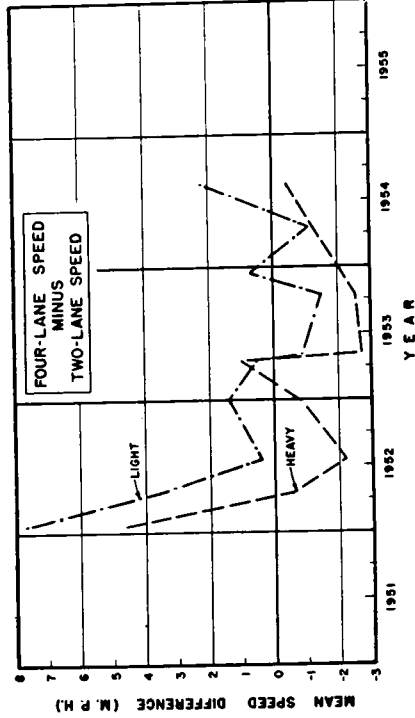
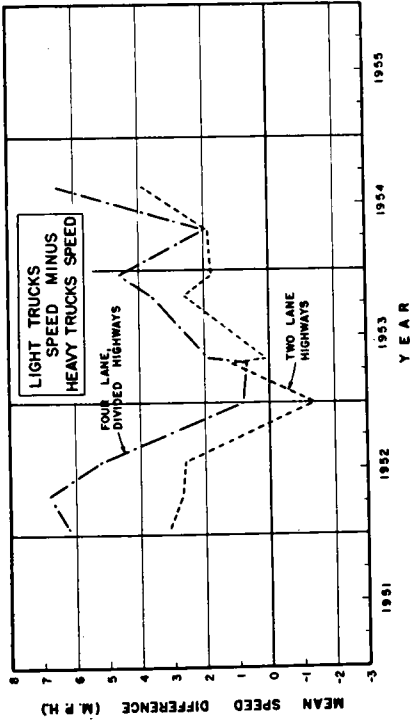


Figure 7. Difference in truck mean speeds.

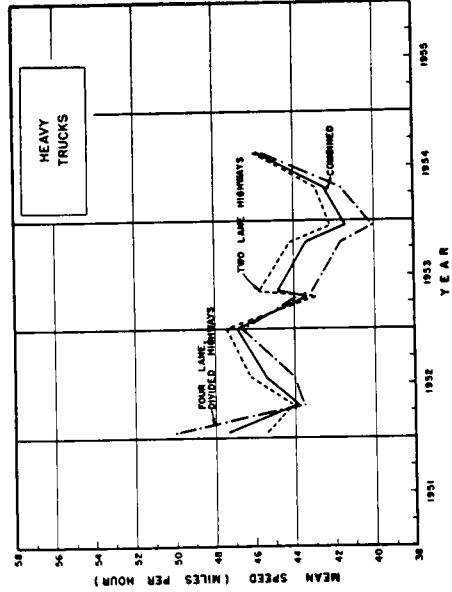
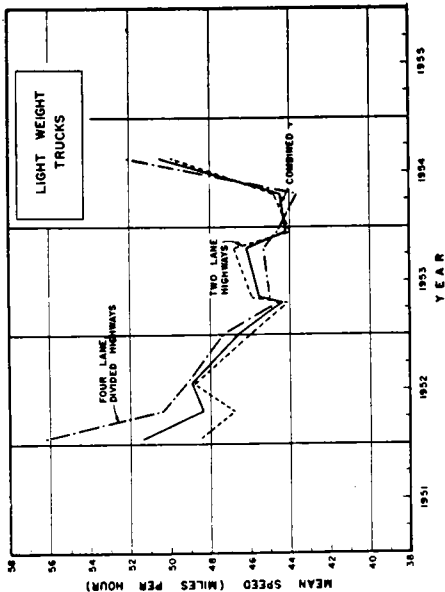


Figure 6. Truck mean speeds versus truck type.

(Figure 7) except in April, 1953, when the two-lane difference was 1.2 mph. while the four-lane difference was 0.7 mph. In the three years, 1952-1954, the least difference between the mean speeds of the two truck types was observed in early 1953. Since that time there have been generally increasing differences until in August, 1954, positive differences (light truck mean speed minus heavy truck mean speed) of 6.5 mph. and 3.9 mph. were observed on the four-lane and two-lane highways, respectively.

The negative values in the lower curves of Figure 7 also indicate the tendency for all trucks, especially the heavy type, to travel faster on the two-lane pavements.

SPEED DIFFERENTIAL CHARACTERISTICS

The term "speed differential" as used in this paper is applied to the difference between the 85-percentile passenger car speed and the 15-percentile heavy truck speed. This range includes speeds normally found to occur and excludes the very high and very low speeds.

The trends in speed differential on four-lane and two-lane highways since 1949 are indicated by the center pair of lines in Figure 8.

The largest speed differential was 32.6 mph. observed on the four-lane highways in April, 1954, and the greatest speed differential observed on the two-lane sections was 28.8 mph. in January, 1952.

The lowest speed differential of 20.1 mph. occurred at the two-lane stations in early May, 1953 while the lowest speed differential on four-lane highways was 22.2 mph. as observed in early April, 1949. Since 1952, the four-lane differential has been higher than the two-lane differential.

The greatest difference between the speed differentials observed on the two highway types was obtained in April, 1954 when the four-lane differential was 5.5 mph. larger than the two-lane differential. Just four months earlier, in December, 1954, the differences were practically equal because the two-lane differential was a negligible 0.2 mph. greater than the four-lane differential.

It is interesting to observe that there has been a continuous overall increase of 5.4 mph. in the 85-percentile passenger car speeds observed on two-lane highways from the low value of 58.4 mph. observed immediately after the adoption of the 65 mph. prima facie

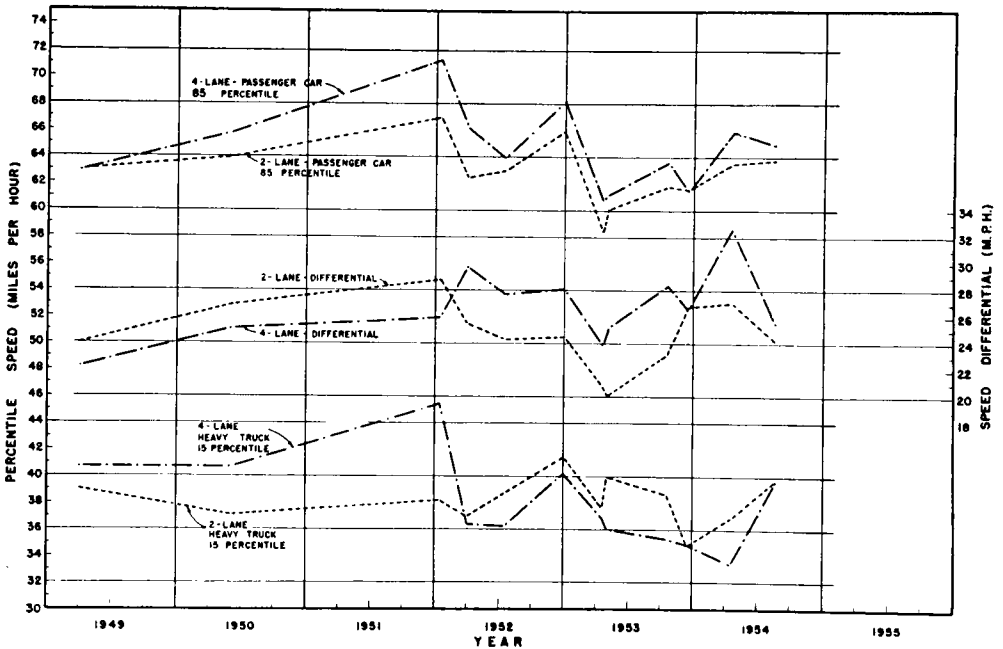


Figure 8. Trends in percentile speeds and speed differential, 1949-1954.



limit to the value of 63.8 mph. recorded in August, 1954.

It should be noted that in August, 1954, the 85-percentile speeds observed on the four-lane highways and two-lane highways were equal to or only 1.2 mph. below the 65 mph. speed limit.

While the high speeds have increased, following the low values obtained immediately after the introduction of the speed limit for all vehicles weighing less than 5000 pounds, the slow speeds, as evidenced by the 15-percentile speed of heavy trucks, have shown no definite trend since April, 1953. In December, 1953 and August, 1954, the 15-percentile speeds were almost identical on two-lane and four-lane highways with only a 0.1 mph. difference evident.

#### SUMMARY

The trend of Indiana motor vehicle speeds, as observed in rural areas by the Purdue University Joint Highway Research Project, may be briefly summarized as follows:

1. Passenger car mean speeds evidenced a general increase from the low value of 42.3 mph. observed early in World War II with a 35 mph. speed limit in effect, to a high value of 59.2 mph. in January, 1952, with the basic rule of "reasonable and prudent" speeds in effect. The mean speed then decreased during the spring and fall of 1952, increased to a value of 57.7 mph. in early January, 1953 and then decreased to a low value of 51.8 mph. in April, 1953 following the adoption of a 65 mph. *prima facie* speed limit the preceding month. There has been an increasing trend in the mean and 85-percentile speeds of passenger cars since the April, 1953 low value. The mean and 85-percentile speeds observed for all passenger cars in August, 1954, were 56.0 mph. and 64.2 mph. respectively.

2. Non-Indiana passenger cars travelled approximately 2.9 and 3.4 mph. faster than Indiana cars on four-lane divided and two-lane highways respectively. While higher mean speeds were observed on four-lane divided highways for both non-Indiana and Indiana cars, there appears to be a tendency to travel almost as fast on a two-lane highway as on a four-lane divided highway having comparable grades and sight distances.

3. The increase in truck speeds since World War II is similar to, but not as great as,

those observed for passenger cars. The mean speed for heavy trucks was 45.9 mph. in August, 1954 with the absolute speed limit for these vehicles being 45 mph.

4. On four-lane, divided highways the mean speed of light trucks was always higher than the mean speed of heavy trucks. On two-lane highways the light truck mean speed was higher except in early January, 1953.

5. The mean speeds of both light and heavy trucks were not consistently higher on the four-lane than on the two-lane highways but have fluctuated in the period of 1952-1954.

6. Since 1949, the speed differential formed by the difference between the 85-percentile passenger car speed and the 15-percentile heavy truck speed has ranged from a high value of 32.6 mph. observed on the four-lane highways in April, 1954, to the low value of 20.1 mph. which was observed on the two-lane pavements in May, 1953. In August, 1954, the four-lane speed differential of 25.5 mph. was only 1.3 mph. higher than the 24.2 mph. two-lane differential.

The 65 mph. *prima facie* speed limit has been in effect almost two years, and the data indicate that any effect of the speed limit on high speeds is diminishing. The Purdue University Joint Highway Research Project, however, will continue to study the trend of mean and 85-percentile passenger speeds which have increased since the introduction of the speed law and the changes induced should a change in enforcement policy be initiated.

Inasmuch as the mean heavy truck speed, as observed in August, 1954, is about one mph. in excess of the 45 mph. absolute limit for these vehicles, it is essential that studies, such as those herein reported, be continued to ascertain the effectiveness and practicality of the existing limit.

Additional study is also necessary to determine if increasing minimum speed regulations are also required to keep the speed differential from increasing, rather than placing complete emphasis on reducing high speeds for the same effect.

#### ACKNOWLEDGMENTS

The assistance of the numerous graduate and undergraduate students, especially R. E. Dunivan, who made many of the field observations and analytical computations, is gratefully acknowledged. The encouragement and

comments of K. B. Woods, H. L. Michael, P. E. Irick, and A. K. Branham of the Joint Highway Research Project is also appreciated.

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